PROCEEDINGS OF OBSERVATORIES.

The following Reports of the proceedings of Observatories during the past year have been received by the Council from the Directors of the several Observatories, who are alone responsible for the same.

Royal Observatory, Greenwich.

During the past year the meridian work at this Observatory has been sensibly increased by the efforts made to complete the forthcoming Ten Year Catalogue of Stars (1877–1886) as far as possible, both by securing places of nearly all stars down to the sixth magnitude inclusive, not observed at Greenwich since 1860, and by obtaining at least three observations of each star. Thus the total number of meridian transits for 1886 is 6,417, and of meridian zenith distances 6,219; the numbers for the month of December alone, when special efforts were made, being 1,133 and 1,093 respectively. The number of stars observed during 1886 is 1,666. At the same time the stellar work has not been allowed to interfere with the regular observations of Sun, Moon, and planets, and the general work in other respects has been rather heavier than in previous years. The proper motions in use have been carefully revised and compared with those of Auwers; and, in the case of clock stars, a further comparison has been made with the last ten years of Greenwich observations, from which it is clear that Auwers' proper motions may be advantageously adopted throughout. They will accordingly be used regularly from January 1, 1887, and also in the formation of the Ten Year Catalogue. As a preliminary to this, the application of proper motion for fraction of the year has been thoroughly examined for every observation in the period 1877–1886, and corrections applied where, as occasionally happened, different proper motions had been used in the same year. Preparations have been made to apply corrections for reduction to Auwers' proper motions, and for reduction to the same R−D correction throughout in the computations for the Ten Year Catalogue.

A considerable amount of information has been obtained as regards personality in observation, both as depending upon direction of measurement or motion, and on the differences between the chronographic and the eye-and-ear method of observing. The reversion prism has been used to observe about 200 transits of clock stars and 200 of polar stars with the transit-circle, and about 550 of the Moon and stars with the altazimuth, more than 200 of these latter being observed by eye and ear. As a general result, it appears that there is in no case any sensible personality depending on the direction of measurement, and that the personality depending on the direction of motion is in every instance very small for clock stars, and insensible for slow-moving polar stars. For the regular observers the eye-and-ear personal equations differ but little from the chronographic, except in one instance, where the difference amounts to as much as $0^{s}\cdot6$. From observations made with the personal equation machine, which has been found to work satisfactorily, and to give results in accordance with those deduced from observations of clock stars, it would appear that all the observers observe too late. Further observations are, however, required to determine the absolute personal equations with certainty. With a view to obtaining a register of the end as well as the beginning of the contacts made by the personal equation machine, a small chronograph, by Krille, made many years ago for mechanical registration, is being adapted by Messrs. E. Dent & Co. to electric registration of make-and-break contacts.

The mean error in R.A. of Hansen's Lunar Tables with Prof. Newcomb's corrections is $+0^{s}\cdot029$ for the year 1886, as deduced from ninety-six observations with the transit-circle; for the years 1883, 1884, 1885, the corresponding quantities were respectively $+0^{s}\cdot032$, $+0^{s}\cdot021$, and $+0^{s}\cdot028$.

Four determinations of flexure of the transit-circle in 1886 gave results $+0''\cdot15$, $+0''\cdot42$, $-0''\cdot16$, and $+0''\cdot13$.

The apparent correction to the nadir observation, deduced from reflexion observations of stars in 1886, is $-0''\cdot09$, the results for individual months showing considerable fluctuations. In comparing this with results for previous years, it is to be remarked that new steel screws were applied to the microscope micrometers on January 1, 1886. It is considered that no correction is now required to the nadir observation.

Experiments on the effect of the limitation of aperture when observations are taken through the central cube of the transit-circle having led to the suspicion that the object-glasses of the collimators might be defective, they have been examined by Mr. Simms, who has reported that they are excellent.

The altazimuth observations of the Moon in the first and last quarters have been regularly continued as before.

Further additions have been made to the Lassell Equatorial, with a view to adapting it to stellar photography. With this object the Corbett Refractor of 6½ inches aperture has been mounted on the cradle of the Lassell telescope, so that the position of the compound instrument can be very conveniently watched by an observer. Slow motion in R.A. with differential wheels, and an improved clamp and slow motion in N.P.D. are being added. A circular camera to carry plates of $8\frac{1}{4}$ inches diameter has been mounted at the principal focus, but no photographs have yet been taken.

Progress has been made in the construction of the new 28-inch refractor. A satisfactory flint-glass disc has been produced by Messrs. Chance, and M. Feil of Paris has undertaken to supply the crown disc. The details of the special tube have been finally settled, and Mr. Grubb is engaged on its construction.

Comet *d* 1885 (Fabry) has been observed on five nights with one or other of the equatorials; Comet *e* 1885 (Barnard) on nine nights; Comet *a* 1886 (Brooks) on six nights, and Comet *f* 1886 (Barnard) on twelve nights. Twenty-four occultations of stars by the Moon have been observed, in five cases by two observers, in one by three observers, and in two by four observers; and forty phenomena of *Jupiter's* satellites, with one or other of the equatorials.

Owing to the pressure of the Sun-spot work and the absence of Mr. Maunder in the summer for observation of the solar eclipse in Grenada, the chromosphere has only been examined on eight days. With respect to measures of the displacements of lines in stellar spectra, 283 comparisons of the F line, and 30 of the *b* lines have been made, the number of stars examined being 54. The displacements of the *b* and F lines in the spectra of *Venus* and *Mars* have also been measured, 20 observations having been made on *Venus* and 19 on *Mars*; while 94 comparisons of the *b* or F lines in the spectrum of the Moon or of the sky have been made for general check on the accuracy of the results; and 5 measures have been obtained of the relative motion of the limbs of *Jupiter*.

The spectra of Mr. Gore's new star in Orion, of 51 Schjellerup, and of Comets *e* 1885 (Barnard) and *f* 1886 (Barnard), have also been examined. Photographs of the Sun, 420 in all, have been taken on 209 days, and these have been supplemented by photographs taken at Dehra Dûn, in India, and at the Royal Alfred Observatory, in Mauritius; so that in the year ending Oct. 31, 1886, there are only 5 days on which no photograph is as yet available for measurement. A very marked decrease in the number of spots is noticeable in 1886, especially in the last six months; indeed, since the middle of September, the Sun has been almost free from spots.

The magnetical and meteorological observations have been carried on on the same lines as in previous years, and the observations of the principal meteor-showers have been continued.

The arrangements for trials of chronometers and deck watches have engaged much attention during the past year, and the business connected with chronometers generally has pressed heavily on the Observatory. One of the clocks returned from the Transit of *Venus* Expedition (1874), has been fitted up at Devonport, under Capt. Wharton's directions, to give time signals to the port. This clock is adapted to give hourly signals (by the collapsing of a cone or drum), and is corrected daily by the help of a time signal from Greenwich at 10 A.M., which automatically starts an auxiliary seconds' pendulum, suspended freely just behind the clock pendulum. The attendant then accelerates or retards his clock pendulum by electro-magnetic action, so as to synchronize it with the free pendulum, indicating Greenwich mean time. Preliminary trials of the clock were made at Greenwich last summer, and it has been in successful action since December 1, a return-signal to Greenwich, sent automatically by the Devonport clock at $1^h\ 0^m\ 39^s$ P.M., giving evidence of the accuracy with which the clock has been corrected.

The volume of Greenwich Observations for 1884, and the separate copies of results, were distributed last October, and the printing of the volume for 1885 is nearly complete. In an appendix to the Greenwich Observations, is given a series of diagrams representing the diurnal change in magnitude and direction of the magnetic horizontal force for each month of the years 1841 to 1876, by Sir G. B. Airy, K.C.B., late Astronomer Royal.

Two members of the staff of this Observatory, Mr. Turner and Mr. Maunder, took part in the expedition to Grenada, West Indies, to observe the total solar eclipse of 1886, August 29.

Armagh Observatory.

The micrometrical observations of nebulæ have been continued with the 10-inch refractor, but during the greater part of the year the weather was very unfavourable for faint objects. The nebulæ on the working list are chiefly such as have not yet been observed with wire micrometers. A great deal of time has been spent in reducing to the epoch of 1860 all the positions of nebulæ published during the last ten years, with a view to the compilation of a new General Catalogue of nebulæ and clusters.

The Second Armagh Catalogue of 3,300 stars was distributed in August last.

Cambridge Observatory.

The zone stars are nearly all now observed, and the reductions are steadily progressing.

The total number of observations of stars made with the Meridian Circle during the year is 2,252; of these 651 were of clock stars, 70 of *Polaris* above the pole, involving 152 circle readings, and the same number below the pole with 169 circle readings; the remaining 1,461 observations were of zone stars.

The Nadir point and level were observed 202 times, the line of collimation 200 times.

The entire number of observations of zone stars, since the commencement, now amounts to 43,576.

The Mean Right Ascensions at the epoch (1875·0) are determined up to July 12, 1877; the Mean Right Ascensions January 1·0 of each year up to the end of 1881; and the True Right Ascensions to September 30, 1886.

The North Polar Distances are reduced to the epoch up to March 16, 1878; the Mean North Polar Distances for January 1·0 of each year to the end of 1881; and the True to November 25, 1886.

511 observations of standard stars made by Mr. Graham in 1885 give +0″·55 for the mean reduction to the standard Berlin places in North Polar Distance, without making any allowance for flexure or errors of division; 82 observations by Miss Walker, nearly all taken by daylight, gave +1″·18. The North Polar Distance was, as in former years, deduced from the observed Nadir point, and the assumed colatitude 37° 47′ 8″·4.

60 observations of *Polaris* above pole, corrected for flexure and errors of division give, for reduction to Berlin N.P.D., +0″·45; while 59 observations below pole, similarly corrected, give −0″·33. These give for the reduction of Cambridge to Berlin N.P.D. for *Polaris* +0″·06, and for correction of assumed colatitude +0″·39.

It may be interesting to compare the colatitudes obtained from *Polaris* and observed Nadir Point for the last eight years.

	°	′	″
1878 . .	37	47	8·86
1879 . .			8·98
1880 . .			8·815
1881 . .			8·755
1882 . .			8·85
1883 . .			8·825
1884 . .			8·96
1885 . .			8·79
Mean . .	37	47	8·854

Polaris was observed directly and by reflection on April 8; the coefficient of correction for level thence deduced is $b = -0^s\cdot337$, the coefficient obtained on the same day by means of the collimators and the reflection of the wires is $b = -0^s\cdot335$; the unit in each case being 15″ of arc.

On May 12, 1886, we furnished Dr. Gustaf Ericsson, of Upsala, with the places for 1875·0 of four of our zone stars which had been compared with the Comet 1863 III., and on November 24 we likewise supplied Mr. Bidschof of Vienna with the places for 1875·0 of nine of the zone stars which had been compared with one or other of the Comets 1848 I. and 1849 III.

Dunsink Observatory.

During the early part of the year the Meridian Circle was employed, along with the chronograph, for observing stars with large proper motion, taken chiefly from the sources mentioned in last year's Report. From the middle of February, however, up till September, the observation of these stars was frequently interrupted for the purpose of completing the list of southern stars referred to in former Reports. The work of filling up the gaps still remaining in this list necessarily occasioned long delays at the telescope, so that the number of observations this year will compare unfavourably with that in former years.

The latter months of the year, from September to December, were almost entirely occupied with the work of preparing for the press the Sixth Part of the Dunsink Observations, which will contain the observations of the southern stars which were commenced by Dr. Dreyer in 1882. This work is now in the hands of the printer, and will shortly be published.

The number of Right Ascensions observed was 506, and of Declinations 295, besides observations of standard stars for the time service to Dublin.

In addition to the usual observations of Right Ascension and Declination, a large number of measures were made in January, February, and December for determining the periodic errors of the microscope screws. The corrections were found to be of the same general character, but smaller than at the last determination.

For the purpose of determining the difference of the radii of the pivots of the Meridian Circle a large number of levellings have been made in both positions of the instrument. They show that the correction for this irregularity is small, but its exact value has not been deduced, as the series of observations is not yet complete.

The results of the observations of the occultation of *Aldebaran* on January 16 which were made at this Observatory have been published in the *Monthly Notices* for February.

Records of the velocity and direction of the wind have been taken as usual throughout the year.

Royal Observatory, Edinburgh.

Through the past twelve months, transit observations for sidereal time, and electrical exhibitions of mean solar time computed for Greenwich, and given to the public by means of time-ball, time-gun, and controlled clocks, have been kept up daily.

The bi-diurnal meteorological observations at 55 stations of the Scottish Meteorological Society have been computed, condensed, and described, partly every month and wholly every quarter, for the Registrar-General of Births, Deaths, &c., in Scotland, in whose printed returns for months and quarters they have accordingly appeared.

During the past autumn the printing of the "Edinburgh Catalogue, Discussion, and Ephemeris of Stars" was completed, published, and distributed in the usual manner as one thick volume, numbered XV. of the Observatory series; and MSS. chiefly spectroscopic are now being prepared for a proposed volume XVI.

A paper has been also written by the Astronomer descriptive of his proposed new method for finishing the Equatorial of the Edinburgh Observatory; but it is kept in abeyance until the scheme of the Government Committee of 1879 shall have been either carried out or given up by those charged with its execution.

The Kew Observatory of the Royal Society, Richmond.

The Sun-spots were delineated and numbered after Schwabe's method, as usual, on 169 days during the past year.

Three hundred and nine observations of solar and sixty-one of sidereal transits have been taken, for the purpose of keeping correct local time at the Observatory, and the clocks and chronometers have also been compared daily.

At the request of General Walker, F.R.S., certain experiments were made with the view of determining the stability of the Experimental House as a site for pendulum operations. These having proved that building unsuitable, a wooden erection of convenient dimensions has been constructed, at the desire of the Pendulum Committee of the Royal Society, in the lower South Hall of the Observatory, on the spot occupied in 1873 by Captain Heaviside, R.E., when experimenting with the Russian pendulum

In this room the Indian Pendulum Apparatus, recently returned by Professor Pierce from the United States, has been erected, in order to repeat the observations made by Colone Herschel, R.E., in 1881, Captain Heaviside in 1873, and Captain Basevi in 1865. Eventually, it is intended to convey the whole to Greenwich, and at the Royal Observatory another series o observations and experiments will be conducted.

The usual magnetical and meteorological observations and reductions, and also the verification of instruments, operations to which the attention of the Observatory is mainly directed, have been carried on as formerly.

Liverpool Observatory, Bidston, Birkenhead.

Careful attention has been given to transit observations of stars for the determination of clock errors. The two sidereal clocks have been compared daily with the normal mean-time clocks, and duplicate comparisons of all the chronometers with the latter have been made daily as heretofore. Greenwich mean time has been communicated to the Port daily, Sundays excepted, by means of the time-gun placed on the Morpeth Dock Pier-Head. No instance in which the gun has failed to fire has occurred during the past year, and the flash has in each case accurately indicated 1 P.M. as shown by the normal clock in the chronometer room. Two hundred and twenty-seven chronometers have been tested during the past year. When the test certificate shows the performance to be unsatisfactory, it is the general practice for the maker to examine and adjust the instrument, and return it to the Observatory to be re-tested. An important service is thus rendered to shipowners and ship-masters by preventing defective and imperfectly-adjusted chronometers being taken to sea. The records received during the past year of the performance at sea of the Pacific Steam Navigation Company's chronometers show that, using the rates corrected for temperature supplied from this Observatory, the average error of longitude by chronometer for an average voyage of 101 days was about four miles.

No alteration has been made in the meteorological work. No interruption has occurred in the records of the self-registering instruments and the daily, weekly, fortnightly, and monthly Reports have been furnished as in previous years.

Radcliffe Observatory, Oxford.

The following have been the subjects of observation during the year 1886:—

With the Transit Circle:—

1. Observations of stars to the seventh magnitude inclusive between 115° N.P.D. and the Equator.

2. Observations of the Moon, which are continued throughout the lunation, and regularly compared with the Right Ascensions and North Polar Distances of Hansen's Lunar Tables. Such comparisons have been generally discontinued at other Observatories; and these results, therefore, appear to have a special value in keeping distinctly before astronomers the extraordinary

character of the change between the results of observation and theory which took place about the year 1864. The mean error in longitude of Hansen's Tables has changed from $-1''\cdot61$ in the year 1863·5 to $+15''\cdot34$ in the year 1886·5, being at the average rate of $0''\cdot74$ per annum.

3. Observations of the Sun.
4. Reflexion observations of stars.

The following table gives the number of observations made during the year 1886 :—

Transits, 2,812.
Circle observations, 2,663.

These totals include—

Observations of the Moon on 49 days.
Observations of the Sun on 76 days.
23 Reflexion observations of stars.
365 Determinations of Nadir point.
2 Durations of passage of the Moon's diameter.
2 Vertical diameters of the Moon.

With the extra-meridional instruments :—

13 observations of 9 occultations of stars by the Moon.

The volume for 1883 has been printed and distributed.

The volume for 1884 is being prepared for press.

The observations made in 1885 and 1886 are completely reduced.

A well-mounted Equatorial by Cooke with an exquisite object-glass of ten inches aperture has been presented to the Observatory by J. Gurney Barclay, Esq. The building for the reception of the instrument has been prepared from designs kindly furnished by Mr. Common, but the continuance of the late severe frost has delayed the arrival and mounting of the instrument.

Oxford University Observatory.

The work of this Observatory has been necessarily confined during the past year to a research as to whether the new process of Astronomical Photography is or is not practically applicable to the most delicate of astronomical investigations, such, for instance, as the determination of Stellar Parallax. The reply is unmistakably in the affirmative, inasmuch as the Parallax of 61^1 and 61^2 *Cygni* has been obtained in reference to no less than four comparison stars, with singularly accordant results. The preliminary particulars have been communicated to the Royal Society and the Royal Astronomical Society.

The attention of the Observatory staff has also been directed to the mounting, renovation, and electric lighting of the excellent Transit Circle presented to the Observatory by Mr. J. G. Barclay.

Temple Observatory, Rugby.

This Observatory has been opened on seventy-six evenings during the year, on most of which there has been the usual attendance of members of the School, when the usual instruction has been given.

Mr. Seabroke has given the whole of his spare time to the measurement of the motion of stars in the line of sight with the spectroscope on the Reflector, and 100 sets of measures have been made.

The results of the last few years have been reduced and lately brought before the notice of the Society.

Mr. Percy Smith has continued the work of measuring the position and distance of double stars, and has been doing clerical work in connection therewith. He has also arranged all our star forms for future re-observation.

Stonyhurst College Observatory.

The solar work continues to receive the same attention as in previous years. The Sun was observed on 235 days, and 224 drawings were made of the whole disk, including spots and faculæ.

Whenever the definition was particularly good the general surface of the Sun has been studied in conjunction with Janssen's excellent photographs, and continual change is seen everywhere.

The measures of the chromosphere and prominences have been more successful than in any other years, 101 complete observations and two partial ones being recorded.

The spectra of Sun-spots were examined on 21 days, and on six of these occasions spot bands were visible. The lines most widened this year were generally the ordinary solar lines, which was far from being the case during the maximum period.

A new class of solar observations has been added to the routine work this year, the direction of the flames of the chromosphere being noted with a wide tangential slit. As these observations require a very perfect sky, and are only made when the others are completed, they are entered only on 21 days.

Positions of the comets of Fabry, Brooks, Barnard, and

Finlay have been determined, and the usual watch kept for the phenomena of *Jupiter's* satellites and for lunar occultations.

In preparation for the total solar eclipse of August 29, a 5½-inch object-glass by Alvan Clark and a powerful direct-vision spectroscope by Hilger were purchased by the college authorities.

Mr. Common's Observatory, Ealing.

The last year has been entirely devoted to the construction of the 5-foot reflector. The machine for grinding was completed in September, and great progress has been made with the mirror. Photography has been used to obtain permanent records of the state of the surface by using the reflected light from a pinhole (illuminated by a lamp), as in the system of testing used by Foucault. It is found that so small a quantity of light as can come through a hole ·004 inch placed at the centre of curvature can be photographed in a few seconds after reflection from the surface.

A series of photographs have been taken from the first rough polish to the present state, and will be continued.

The kind of mounting has been determined upon, and the heavy work put in hand. It is hoped that the whole may now be completed without further delay.

The telescope is to be devoted to photography, and the mounting has been designed to give the greatest amount of steadiness and perfection of movement.

The Earl of Crawford's Observatory, Dunecht.

Early in the year Dr. L. Becker concluded the determination of the latitude by prime vertical observations begun in 1885. This involved an exact examination of the pivots with the level, which proved particularly interesting, as it could be made in both the pairs of Y's with which the instrument is provided. The maximum error is 0″·66, corresponding to 0·00006 inch; but only a small fraction of this affects the telescope when near the zenith. The general figure of the axis comes out the same when rotated in the meridional bearings, as in those for the prime vertical. The observations are all reduced.

In the moonless nights of the autumn Dr. Becker turned the large aperture of the Transit Circle to account by observing nebulæ; in this way ninety-six places have been secured in seventeen nights. The bright nights were devoted to comparison stars and to a complete re-determination of the positions of the

1887MNRAS..47R.158.

Durchmusterung stars within 1° of the pole. This latter work is carried on with bright-field illumination. Observing was commenced on eighty-three nights, but on only forty-five of these did the clouds permit of fairly continuous work.

During the past year the 15-inch Equatorial has been used almost solely for spectroscopic observations. A few measures of double stars or of faint stars in the Great Nebula in *Andromeda*, or near Mr. Gore's variable star in *Orion*, were taken when the spectroscope was dismounted.

The large star spectroscope mentioned in former Reports was punctually finished by Messrs. T. Cooke and Sons in March. It works well in all respects. The single flint prism of 60° supplied with the instrument defines so well, that, with a dispersion of only 5° 7′ from A to H, it separates the pair of lines $488{\cdot}81^{\text{mmm}}$ and $488{\cdot}84^{\text{mmm}}$, and shows forty-three lines between B and C. All three lines in the ring nebula in *Lyra* can be measured without difficulty. A prism of 20° refracting angle, by Merz, promises to be very useful for faint stars, while a large compound prism by Mr. Grubb gives about as much dispersion as even the brighter stars will satisfactorily bear.

The solar spectrum was measured on twenty-one days to obtain data for reducing observations of other spectra. A very pliable formula with three coefficients devised by Dr. Becker represents the minimum deviations from A to H for the 60° prism to within about 20″, leaving outstanding errors that can be dealt with graphically.

Owing to its unfavourable position Brooks' first comet was only observed once with the large spectroscope, but both it and Fabry's comet were observed three times with a smaller instrument. Barnard's October comet was examined on eight occasions with the new spectroscope, and was photographed on the 16th, 17th, and 26th December with a 4-inch lens. The two earlier photographs show the lateral tail.

Twenty-three circulars were issued in the year, all dealing with comets, with the addition of two notes on *Jupiter's* fourth satellite. Observers are again largely indebted to Dr. H. Oppenheim for elements and ephemerides of comets.

Comet Brooks (2) of 1885 could not be found on March 9 and 11 by Dr. Becker, although the ephemeris afforded some hope that it might be visible.

The weekly time-gun and the meteorological observations have been continued as usual.

The maximum and minimum thermometers were stolen on August 2.

Mr. Edward Crossley's Observatory, Bermerside, Halifax.

The observations made in 1886 were similar to those in previous years. Of the satellite phenomena of *Saturn* thirteen observations were obtained, and ten of those of *Jupiter.* Some 180 measures with the wedge photometer were made, and forty stars observed with the Transit Circle for time. The 3-ft. Reflector has taken up a good deal of time. The dome for this instrument is now complete: it can be moved round once in five minutes or once in twenty-four hours by a water-engine with two speeds. The observing platform and gallery are suspended from the dome, and therefore the observer moves with the dome. The opening is 6 feet wide from top to bottom, and extends from the horizon to 3 feet beyond the zenith. The shutter is in two pieces, which move horizontally; and one handle opens and closes both in about one minute. The Reflector is now in good working order, and the clock drives well. The mirror will soon need re-silvering, as it has been much exposed to damp, &c., during the erection of the Observatory.

Mr. C. E. Peek's Observatory, Lyme Regis.

The equatorial (of $6\frac{4}{10}$ inches aperture) has been employed in the systematic observation of variable stars from a selected list: 146 nights were suitable for observation. Transit observations for time have been taken on all available nights. The most cloudy month was February; the clearest, December.

The Earl of Rosse's Observatory, Birr Castle.

During the year 1886 some experiments have been carried on at intervals with a view of increasing the accuracy of the apparatus for measuring Lunar Radiant Heat, but they are still only in progress.

Some photographs of the Moon were taken towards the close of the year. Several are of average good quality, and show in every case, and especially with the longer exposures, a decided advantage from the electric control of the driving clock, which had not been applied at the time when the last photographs were taken. In attempts to photograph the Great Nebula in *Orion,* however, the tilting of the speculum upon its supports during the prolonged exposure still causes serious difficulty. No hand-correction has been as yet resorted to.

About eighty sketches of the planet *Jupiter*, which have accumulated since the last series was published, are awaiting publication when some decision as to the best mode of reproducing them shall have been arrived at.

Dr. Boeddicker has, during a considerable number of nights, been engaged upon an eye-sketch of all the Milky Way, so far as it can be satisfactorily reached in this latitude, and he hopes to represent it in more minute detail than has hitherto been done.

Meteorological observations have been carried on as usual.

Colonel Tomline's Observatory.

The work at this Observatory has suffered some interruption owing to the illness of the observer, but it is now again fully resumed. The observation of comets continues, as for some years past, to be the principal work to which the instrumental means are devoted, as it also appears to be that for which they are best fitted. Progress has been made in the reduction of previous observations, and two communications containing results of observations have been made to the *Astronomische Nachrichten* within the past year. They will be found in Nos. 2,723 and 2,754, and comprise observations of Comets 1884 III. Wolf, 1885 I. Encke's, 1885 II. Barnard, 1886 I. Fabry, 1886 II. Barnard, and 1886 V. Brooks I. At the time of the latter publication the whole of the cometary work at this Observatory had been reduced and published. Subsequently satisfactory series of observations have been made of comets Barnard-Hartwig and Finlay: the former having been observed on twenty and the latter on fifteen occasions, while both series are at the end of the year still incomplete. Efforts will be made to publish these at an early date, and thus avoid the accumulation of arrears in future.

Lieutenant-Colonel Tupman's Observatory, Harrow.

The Meridian Circle has been employed in the determination of the places of comparison stars and stars which have been occulted by the Moon. Five hundred and fifty observations of both elements have been obtained, about one-third of which are of fundamental stars. The errors of division of the circle have not been investigated; and the Nadir observation being generally difficult, owing to the vibrations of the soil, the Declinations of stars are determined by comparing them with the fundamental stars, on the same principle as is customary for Right Ascensions. All the star observations are reduced to the mean places for the beginning of the year. Seventeen observations were made of the R.A. of the Moon's bright limb, and two of the horizontal diameter.

With the Equatoreals twenty-one occultations have been observed. The final equations in the Greenwich form have been computed for forty-seven occultations, observed between 1884, October 4, and 1887, February 10.

Comet 1886 I. (Fabry) was observed for place altogether on nineteen nights between 1885, December 7, and 1886, April 1; Comet 1886 II. (Barnard), on fourteen nights between 1885, December 27, and 1886, April 15; Comet 1886 V. (Brooks I.) on four nights between May 6 and May 20. These observations are completely reduced, and all the comparison of stars have been observed on the Meridian two or three times. Comet Barnard-Hartwig, at present visible, has been observed for place on seven nights between December 19 and January 5.

The 18-inch Reflector has been fitted with a new declination-axis, and is now sufficiently rigid; but the driving movement is very irregular.

An instrument by Kahler, of Washington, D.C., for determining absolute personal equations in observing transits, has been brought into use with the Morse chronograph.

Mr. Wigglesworth's Observatory, Scarborough.

The building of the observatory was commenced in the summer of 1884, and by the end of the year the dome was ready for the reception of the instrument. The dome is 30 feet in diameter, hemispherical in shape, and covered with very strong papier-mâché, $\frac{1}{3}$ inch in thickness, which is rivetted with copper rivets to the framework of T-iron. The shutter is of a construction originally introduced by Messrs. T. Cooke & Sons. It has the form of a semicircle striding over the dome. The tail end terminates as a pivot, while the other end, which is the base of the real shutter, rests on a rail. The shutter therefore turns round the pivot in a circle of more than 30 feet radius. It moves with great ease, and practically without noise. On the top of the dome is another rail, to steady the shutter in case of a strong wind. The slit has a width of 5 feet 10 inches at the bottom, and of fully 3 feet at the top. The dome is supported by a brick wall 13 feet in height from the floor to the top of the flat rail on which the wheels of the dome are running. The dome is turned by a cogwheel running in a rack-circle, and is moved with great ease. The rigidity of the dome is very great; it has never been noticed to shake, even when the wind was very strong.

The telescope, which was also constructed by Messrs. T. Cooke

& Sons, was set up in the dome in February 1885. The object-glass, which is a very fine one, has a clear aperture of 15·5 inches, and a focal length of 231·5 inches. The mounting is executed in Cooke's well-known style. Both the polar axis and the declination axis are of steel. There are no friction wheels to the latter, but the instrument turns with great ease in declination. The hour circle reads to 2 seconds of time, and the declination circle to 10 seconds of arc. The latter is read from the eye end of the instrument. The clamps and slow motions in right ascension and declination are worked from the eye end. The driving-clock is of the same construction as that at Dunecht, but without the electric control. There are two finders of 2·5 inches aperture. In front of the object-glass is an iris-diaphragm, by which the aperture may be reduced down to 4 inches. It is worked by a rod from the eye end, and the aperture is read off on a dial. It has been found very convenient on many occasions; the full aperture, however, gives as a rule the best definition.

The mean-time clock is believed to be a unique specimen. It was invented and made at the beginning of this century by George Prior, who was a watchmaker in Leeds, and who received a medal of the Society of Arts for the escapement in this clock. For a long time it was the standard clock of Leeds; after the death of George Prior, however, it came into the possession of Mr. Wigglesworth. The impulse received by the pendulum is independent of the train of the clock; it is given every alternate second by a spring, which is then pushed back to its starting-point by a tooth of the escapement wheel. There is a great difference between the two drops of the escapement wheel; the one is nearly three times as large as the other, and on this difference depends the impulse given by the spring to the pendulum. At the long drop the spring is pushed back; at the short drop it is released, and gives impulse to the pendulum until it is arrested by the next tooth of the escapement wheel. The length of the drop is best seen by the motion of the seconds hand, which shows alternately long and short seconds; the beat, however, is perfectly even—one second is as long as the other. The locking is effected by jewelled detent springs, which are independent of each other. Steel and zinc bars form the compensation of the pendulum, and by the addition of a very small mechanism they have also been made to act as a metallic thermometer. The clock keeps very good time, and has a clear, sharp beat.

There are two spectroscopes by Browning, a reversion spectroscope for observing the Sun, and a McClean star spectroscope.

A micrometer by Merz was kindly lent by Lord Crawford in July 1885. It has only one micrometer screw, but a fine movement can be given to the whole micrometer by two screws in the adapter, which is a more convenient arrangement than to have two micrometer screws.

Regular observations were commenced in September 1885.

The value of the micrometer screw was determined from numerous transits of *Polaris*.

The new star in *Andromeda* was observed on fourteen nights, and the results have been published in the *Monthly Notices*.

Nova *Cygni* was examined on several occasions.

Gore's new star was examined with the spectroscope and measured from neighbouring stars on two occasions.

The dimensions of *Saturn* were also measured with the micrometer.

Comet 1885 *a* Barnard was observed for place on two nights.

Comets 1885 *d* Fabry, and 1885 *e* Barnard, were each observed on five nights.

In 1886 the observations were of a similar kind.

The dimensions of *Saturn* were measured on one occasion.

The nebula in *Andromeda* was examined on several occasions, but no changes could be detected in it. The same was the case with Nova *Cygni*.

Gore's new star was measured on three nights.

Comet 1885 *e* Barnard was observed once in this year.

Comet 1886 *f* Barnard-Hartwig was observed on twenty-one nights, and some sketches of it were also made.

Comet Finlay was observed twice.

The minor planet *Sappho* has been observed six times at the request of Mr. R. Bryant.

A want of star places has often made a delay in the reductions inevitable.

The adopted co-ordinates of the observatory have been taken from the 6-inch survey map, and are—

Longitude of Observatory = $1^{m}\ 38^{s}\cdot9$ west of Greenwich.
Latitude „ = $+\ 54°\ 16'\ 30''$.

The height above the level of the sea is about 150 feet.

Royal Observatory, Cape of Good Hope.

The present report includes the period January 1 to December 31, 1886.

Observations with the transit-circle have been continued regularly throughout the year, the objects of observation being the Sun, *Mercury* and *Venus*, the stars on the list of the Cape Ten Year Catalogue for 1890, comet comparison stars, stars occulted by the Moon, stars employed in determining latitudes in connection with the Geodetic Survey, and stars employed in zones for determining the scale-value of the heliometer. The work accomplished has been:—

Number of determinations of collimation			53
,, ,,	level		510
,, ,,	Nadir Point		463
,, ,,	runs		455
,, ,,	horizontal flexure		47
Observations of meridian mark (from April 5)			439

	Direct.	Reflex.
Number of observations of stars in R.A.	5333	634
,, ,, ,, N.P.D.	4531	634
Observations of both limbs of the Sun in both elements	191	
Observations of Mercury in both elements	109	
,, Venus ,, ,,	142	

The errors of all the new steel screws of the circle microscopes have been very thoroughly determined; and they prove, though small, to be appreciable.

Since April 5 regular observations have been made on a meridian mark, placed in the focus of a lens of about 200 feet focal length, situate to the south of the transit-circle. This mark is observed at the beginning and end of each series of observations, and it appears that the transit-circle has a very small diurnal motion in azimuth, over which observations of the mark afford an efficient control. During the winter period, April 1 to September 30, observations were regularly made on every available morning before sunrise as well as in the evening; thus a large number of double transits of circumpolars have been secured.

A great deal of time and care have been devoted to the Great Indian Theodolite, the study of its constants, and the development of the best plan of working. The errors of division of the horizontal circle have been thoroughly investigated—a work of great labour, requiring special adaptations in consequence of the peculiar form of the instrument, and of which an account will be communicated to the Society. The best arrangement of the azimuth marks has been a matter of considerable experiment. When the space between the marks and the long focus lenses is left open the images of the marks are generally ill-defined, because of ascending currents of air from the soil which has been heated by a strong sun during the day. The experiment was tried of enclosing the space between one long focus lens and the corresponding mark by means of a wooden tube or tunnel 1 foot square. The effect was to produce a great apparent improvement in the steadiness and sharpness of definition of the mark; but, unfortunately, measurements showed that this improvement was accompanied with a slow oscillation of the mark, which seemed far more likely to produce systematic error than the rapid irregular vibrations of the marks before the tube was used. It is possible that by protecting the tube from direct rays of the Sun, by means of a long narrow shed, with sides as well as roof, this slow movement of the mark might be reduced or eliminated; but the experiment was not carried out because of its considerable cost and its problematical success. Accordingly, after much experiment, the wooden tube was removed, and the observations were resumed with open-air space between the lenses and the marks. The stability of the relative azimuth of the marks continues to be very satisfactory. The illumination of the theodolite by small incandescent lamps and storage batteries has proved most successful, and the system has been extended to the azimuth marks and the zenith telescope with the most satisfactory results. Indeed, any one who has once employed electric incandescent lamps for illumination of his instruments, especially in a windy neighbourhood, will never willingly return to the flicker, heat, and general inconvenience of oil lamps. A proposal has been made, and partly carried out, for extending electric illumination to all the instruments of the Observatory.

The following observations have been made with the Great Theodolite:—

Observations of meridian marks	73
Azimuths at greatest elongation	229
„ of N. Stars for latitude by Kapteyn's method .	32 pairs.

With the zenith telescope an investigation has been made of the value and temperature-coefficients of the screw by observations in summer and winter, and 104 pairs of stars have been observed for difference of meridian zenith distance.

The general rule has been adhered to of observing all comets visible south of the Equator, or which otherwise cannot be conveniently observed in the Northern Hemisphere. The fulfilment of this programme has led to a considerable amount of work in the past year.

Winnecke's Comet, which was only seen during fourteen days in 1875, and not at all at the opposition of 1881, was swept for and found by Mr. Finlay on August 19, 5½° from the predicted place of Dr. Lamp's *Ephemeris* (*Astron. Nach.* 2,720, 2,731), corresponding to a time of perihelion passage twelve days earlier than predicted.

On Sunday, September 26, Mr. Finlay discovered another periodic comet, which, if identical with the comet of De Vico, has not been observed since the year of its discovery in 1844.

The following is a list of the observations of comets made during the year:—

Fabry	was observed on	31	nights	between	May 1	and	July 30.
☄ Barnard	,,	18	,,	,,	May 29	,,	July 26.
☄ Brooks I.	,,	13	,,	,,	July 5	,,	July 30.
☄ Winnecke	,,	32	,,	,,	Aug. 19	,,	Nov. 29.
☄ Finlay	,,	34	,,	,,	Sept. 26	,,	Dec. 28.

A paper containing the results of these observations will be communicated to the Society at the March meeting.

Occultations of thirty-two stars and three planets by the Moon have been observed during the year.

The result of observations of stars with the transit-circle for 1882, 83, 84, and till 1885, February 7, are reduced, and will be passed through press by H.M. Astronomer when in England. The Catalogue for 1885, from the meridian observations 1879–85, is in progress.

Aided by the vote of 300*l.* from the Government Grant Fund of the Royal Society, the services of Mr. C. Ray Woods have been continued as photographic assistant.

The extension of the Photographic *Durchmusterung* has been pushed forward as rapidly as possible. Pictures for the whole sky from declination −57° to −90° have now been obtained in duplicate, and considerable progress has been made in further zones towards the Equator. The following amount of work has been secured during the year:—

Perfectly successful *Durchmusterung* plates, exposed one hour in clear sky	263
Plates for special purposes	37
Plates exposed for more than an hour, such as comets, star clusters, &c.	11
Failures	16
	327*

The new photographic objective of 9 inches aperture and 9 feet focus, presented by Mr. Nasmyth, has been received from Mr. Grubb, and also a new 6-inch Dallmeyer rapid rectilinear lens (bought by a grant from the Government Grant Fund of the Royal Society). These, together with a guiding telescope of 5 inches aperture and 9½ feet focal length, have been mounted after a design by H.M. Astronomer on a single powerful stand at his private expense, and the work has been continued since September 30 with the new apparatus. This apparatus is fitted with refined means for centring, and with fine scales for focussing, and also with means for giving definite orientation, defined by a ground edge on the sensitive plate, which edge rests by spring pressure upon two cylinders that have rigid relation to the declination axis. The dark slides are of metal. The whole apparatus was made by Mr. Grubb, and is found to give very satisfactory results.

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* The dismounting of the old apparatus, and the erection of the Nasmyth telescope, &c., in a more convenient observatory, caused some interruption of regular work.

Each picture of the *Durchmusterung* photographs taken with the Dallmeyer lens has now a corresponding picture for the central position of its area (perfect over four square degrees), taken simultaneously by means of the Nasmyth lens, and showing stars to a higher order of magnitude. The enumeration of the stars in the corresponding areas of the two pictures will furnish very valuable data for discussing the distribution of stars of different orders of magnitude, after the comparative light-factor for the two lenses has been accurately determined. Some pictures of remarkable star clusters, &c., have been obtained with the Nasmyth lens.

For the reduction of the *Durchmusterung* pictures, H.M. Astronomer has received a noble offer of co-operation from Prof. J. C. Kapteyn, of Grœningen. Appreciating the importance of the work, and the suitability of the means to the end, Prof. Kapteyn proposed to devote his own time and that of three assistants during the next seven years to measurement and reduction of the *Durchmusterung* photographs, and the preparation of a catalogue somewhat resembling that of Argelander. Such an offer from one so capable and so devoted could not but be gratefully and cordially accepted. Accordingly the pictures from S.P.D. 0° to 13° were forwarded to him, together with duplicate plates of an area in the neighbourhood of the Equator for comparison with Argelander. This comparison showed that whilst with a *very few* exceptions (probably red stars) *all* the stars of the *Durchmusterung*, including those of the 9·5 magnitude, are shown on the plate, there are about 30 per cent. more stars on the plates than are contained in Argelander's work. After much discussion by correspondence, a method of observation was arranged by which the Right Ascensions and Declinations of the stars, reduced to the equinox of the Catalogue, are obtained directly from the instrumental measurement; the instrumental results require only small final corrections for index errors, orientation, &c., which can be easily tabulated from comparison of the instrumental and tabular R.A. and Declin. of the known stars. A rough temporary apparatus was arranged by Prof. Kapteyn, which it was resolved to employ for obtaining preliminary plates of the stars within 10° of the South Pole, and with the working catalogue so formed, it will be then easy to observe all these stars in zones with the Cape transit-circle. Thus the first portion of the *Durchmusterung* would be published with places exact to 1″ of arc. With the preliminary apparatus Prof. Kapteyn had already measured in duplicate all the stars within 10° of the South Pole from R.A. $23^h\ 10^m$ to $9^h\ 50^m$. The accuracy obtained with the rough apparatus has exceeded expectations, as will be shown by the following comparison of the instrumental R.A. and Declin. with corresponding tabular places of the Cape 1880 Catalogue:—

	By	Deduced Declin. of zero of scale.	Index error in R.A.
		° ′	″
Zone IX.	Stone 2948	80 29·5	+ 16
	3290	29·5	+ 15
	3380	29·5	+ 10
	3457	29·6	+ 18
	3680	29·5	+ 18
	4084	29·7	+ 18
	4486	29·5	+ 20

The Declinations are read off by estimation to 0′·1, from a glass scale, graduated to 1′ of arc, placed in focus of the small telescope by which the photograph is viewed; and the R.A. is read off by estimation to 2^s of time, by a small circle graduated to 20^s attached to and rotating with the axis, which serves as the polar axis of the arrangement. There seems to be little doubt that, with a more refined measuring apparatus the places of stars can be determined from the photographs to a single second of arc, without much additional trouble on the part of the observer. An apparatus amply providing for this accuracy has been devised by H.M. Astronomer, and he hopes to be able to have it executed during his approaching visit to Europe.

A very laborious attempt has been made since July 20, 1885, to photograph the Corona by Dr. Huggins's method. From time to time some of the pictures obtained showed persistent similarity, under conditions which appeared to preclude the possibility of instrumental error, but no gradual change could be traced in these appearances, such as one might expect in the representation of successive features of the true Corona.

With every confidence in the method, and with laborious care, some hundreds of these pictures have been taken and examined in different ways and in different lights, and the appearances have also been discussed in relation to the elongations of *Mercury* and *Venus*, as suggested by Dr. Huggins. The most hopeful series have been independently drawn by Mr. Wesley, with results as to the general features of the pictures of the same day coinciding with those remarked at the Cape, but the results, while sometimes leading to hope of success, have never brought the conviction that the true Corona had been really photographed. The crucial test as to whether the dark body of the Moon could be photographed against the background of the Corona was tried under favourable atmospheric conditions on the occasion of the partial eclipse of August 29. No trace whatever of the dark body of the Moon outside the Sun's limb could be discovered on the pictures, and it appears that further experiments in this direction, to be successful, must be made at a higher altitude, or at a time when the Sun's Corona is brighter than the recent eclipse observations show it to be at present.

The new observatory for the heliometer is completed. Messrs. Repsold report that the new heliometer will be finished in the end of February, and H.M. Astronomer has received instructions from the Admiralty to visit Europe for the purpose of inspecting it before it is sent to the Cape.

The Geodetic Survey continues to make considerable progress, notwithstanding somewhat disheartening conditions—viz. reduction of the vote by one-third of its amount, on account of the depressed financial condition of the Colony. In consequence of this reduction the services of Lieut. Laffan, R.E., have been transferred to the Survey of British Bechuanaland, the staff otherwise reduced, and the equipment and transport reorganised. Captain Morris, R.E., has carried on the field work in these new and more trying conditions with the same energy and ability as formerly. The triangulation has been carried from Natal through Griqualand East to King William's Town in the Cape Colony, and the stations have been selected and beaconed from King William's Town to Port Elizabeth.

H.M. Astronomer has taken part in measurement of a base line at Port Elizabeth, of which an account will be communicated to the Society. The extension of this base to the first great side is now in progress. The subsequent measure of the angles of the triangles already selected and beaconed between Port Elizabeth and King William's Town will be completed in June, when Baily's existing triangles between Sir T. Maclear's southern stations and Port Elizabeth will complete a chain of triangles about 1,300 miles in length, checked by three base lines and with numerous astronomical stations, which should afford some valuable geodetic data.

Lieut. Laffan, R.E., has compared his personal equation with Mr. Pett at the Observatory on four nights, not by the usual methods, but by actual determination of the longitude of a hut on the Observatory grounds by telegraphic exchange of signals, as in the ordinary process of a longitude operation; the results, therefore, include the relative personal equation of the observers in giving and receiving signals as well as in determination of time.

The longitude of the following points on the Geodetic Survey have been determined by telegraphic exchange of signals with Captain Morris:—

Umtata, by exchange on 6 nights.
Berlin, ,, ,, 4 ,,

and the longitude of Dryhartz, in British Bechuanaland, by exchange of signals with Lieut. Laffan, R.E., on five nights.

The heavy pressure of a great variety of work requiring the close personal attention of H.M. Astronomer has rendered it impossible to complete the reduction of the observations of *Victoria* and *Sappho* in 1882, but it is expected that the work will be pushed to completion before the end of the year.

The Meteorological Observations made in the year 1885 at the Observatory, together with those taken in different parts of the Colony, have been printed in the Reports of the Cape Meteorological Commission.

Hong Kong Observatory.

The second annual volume was published early in the summer, and the third volume will probably be ready for distribution within a few months. The meteorological observations and researches have been extended, and kept up to date since the appointment of an additional clerk. Absolute magnetic observations were made monthly, and Sir W. Thomson's automatic tide-gauge was erected and worked since the end of October.

The electric time-ball was dropped as usual at 1 P.M., and the sidereal standard clock was kept going without being touched throughout the year. As soon as two years' ten-day rates are available, it is intended to re-examine the coefficients.

Micrometric measures of *Jupiter* and *Saturn* occasionally made since 1879 have been reduced, and will be published in the astronomical Report.

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